

REMARKS

We are in receipt of the Office Action of April 29, 2003, and the accompanying Amendment and following remarks are made in light thereof.

The present invention is directed to a novel method for making a graphite intercalation compound ("GIC"). As explained in the specification, a GIC is lamellar graphite which has an intercalation compound introduced between the interlayers thereof. Upon heating, the intercalation compound expands. The resultant expanded graphite has a number of uses, such as the making of seals and gaskets for high temperature applications, or in the electrode active material in power sources.

By the present invention, the GIC is created by immersing graphite particles in an aqueous electrolyte media comprising both an acid and an oxidizing agent. The immersed graphite particles are then subjected to an anodic current.

The GICs produced by the inventive method can be expanded to unexpectedly higher volumes than GICs made by either electrolytic intercalation in an acid (as disclosed in Watanabe et al. 4,350,576) or chemical intercalation in an aqueous acid and an aqueous oxidizing agent (as disclosed in Greinke et al. 4,895,713). This is confirmed by each of the Examples 1-4 set forth in the specification, where the GIC was made with an aqueous electrolyte comprising both an acid and an oxidizing agent and subjected to a polarizing current. These GICs

achieved exfoliation efficiencies of as high as 800 to nearly 1200 ml/g (Figs. 3-6), whereas when only a single acid was used for the electrolyte, the highest value for exfoliation efficiency was 240 ml/g (Example 5, Fig. 7).

Turning to the Office Action, Claims 1-19 are pending in the application. Claims 1, 4-7, and 17-19 stand rejected for being obvious over either Holderness et al. 6,319,391 or Argade 5,032,240. Claims 2, 3 and 8-14 stand rejected for obviousness over Argade in view of Sorensen et al. 4,555,393. Claims 1-19 also stand rejected for indefiniteness the examiner noting, with respect to Claim 1, that an acid can also be an oxidizing agent. The examiner also finds the term "rapid" in Claims 17 and 18 to be "subjective and unclear".

Applicant notes that the examiner has taken no action with respect to Claims 15 and 16. These claims are multiple dependent claims depending from Claims 1 or 9 and are directed to a method in which the graphite particles are placed in a rotatable plating barrel prior to immersion in the electrolytic solution. Because the examiner has cited no art for this limitation, applicant assumes that the examiner considers these claims to be directed to allowable subject matter, and are objected to only for being dependent from a rejected base claim (assuming that the indefiniteness issue can be resolved).

Turning first to the rejection for indefiniteness, applicant submits that the reference to both an acid and an

oxidizing agent in Claim 1 does not render the claim indefinite. Persons of skill in the art of graphite intercalation recognize the fact that an acid can also be an oxidizing agent and that chemical intercalation can be accomplished with mixtures of two acids, one of them constituting an oxidizing agent. See, e.g., Greinke et al. 4,895,713, Col. 4, Lines 12-33. Applicant notes that oxidizing agents in addition to acids are also disclosed and claimed in the present application, including CrO_3 , KMnO_4 , $(\text{NH}_4)_2\text{SO}_4$, PbO_2 , MnO_2 , MnO , and H_2O_2 .

With respect to the examiner's assertion that term "rapid" is "subjective and unclear", Claims 17 and 18 have been amended to delete this term and Claim 17 has been amended to also call for heating "for from approximately from 1 second to 10 minutes", similar to Claim 18. The Summary of the Invention has also been amended to reflect the time of heating being from 1 second to 10 minutes. Applicant submits that no new matter is being added to the application by this amendment, as the recited time of heating appears in Claim 18, as filed.

Turning to the rejection for obviousness, none of the references cited by the examiner, taken either singly or together, describe a method for making a GIC, nor do the processes that are described in the references result in a GIC.

Specifically, Holderness et al. describes the method for treating scrap graphite - -not graphite particles- - to remove metal contaminants (uranium from casting fuel rods) that may be

adhered thereto- - not to make GICs. Holderness et al. accomplish this by placing the scrap graphite in an aqueous oxidizing electrolyte (nitric and/or sulfuric acid), and passing an electric current therethrough. The graphite body disintegrates and the metal dissolves. The graphite can then be washed and removed to a dump as non-hazard waste.

Argade is directed to a method of activating a carboneous electrode, which may comprise graphite, including providing an aqueous electrolyte of sulfuric acid that is circulated through the electrode, and passing electrical current through the electrode. The electrode is then used in a molten salt lithium-aluminum/chloride battery. Again, Argade does not treat graphite particles and does not create a GIC.

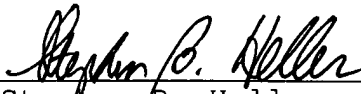
Sorensen et al. is directed to a method for making carbon micro fibers for use in fiber-reinforced composite materials. In Sorensen et al., commercially available carbon fibers are immersed in an intercalating acid solution comprising fuming nitric acid and sulfuric acid to loosen the intercrystallite bonds between the graphitic planes. Carbon micro fibers are then separated from the primary fibers. In the manufacture of the composite material, the carbon microfibers are randomly dispersed between the interstices of the primary fibers to increase the transverse properties of the composite. Once again, Sorensen et al. does not treat graphite particles and does not create a GIC.

Applicant submits that these references are essentially irrelevant to the claimed process and product and certainly do not render the claimed invention obvious.

Based upon the foregoing, applicant that the pending claims are allowable over the art cited by the examiner, and an early office action allowing the application is earnestly solicited.

Respectfully submitted,

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